PRIVATE AND CONFIDENTIAL

RESEARCH DEPARTMENT

Reflectors in concert halls and orchestral studios

RESEARCH REPORT No. B-073/2

1964/68

THE BRITISH BROADCASTING CORPORATION
ENGINEERING DIVISION

PRIVATE AND CONFIDENTIAL

RESEARCH DEPARTMENT

REFLECTORS IN CONCERT HALLS AND ORCHESTRAL STUDIOS

Research Report No. B-073/2

(1964/68)

D. Maurice

T. Somerville, B.Sc., M.I.E.E., F.Inst.P.
C.L.S. Gilford, M.Sc., F.Inst.P., A.M.I.E.E.

(R.D.A. Maurice)

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SUMMARY

This report describes the modifications to the stage area carried out in Southampton Guildhall to improve the acoustics.

The modifications consisted of diffusing surfaces which appear to have been effective in enabling the performers to hear each other, and in improving the tonal quality for the audience.

1. INTRODUCTION

Research Department Report B-073 described experiments with reflectors in Southampton Guildhall, which demonstrated very clearly their effect on the acoustics. As a result of these experiments it was decided not to use reflectors in the reconstruction of the stage area and in the report the following remedial measures were specified to improve the acoustics.

(i) Open up the stage area if possible.

(ii) Replace the reflector behind the orchestra by a diffusing form of surface, adding diffusing surfaces on the side walls of the stage to increase diffusion on the stage itself.

(iii) Provide an absorbent dado behind the orchestra to control the volume of the heavy brass and percussion instruments.

(iv) Take steps to eliminate the low frequency colourations which appear to be due to the panel resonances in the stage area. If the rear panelling were replaced by an absorbent dado, only the side panelling would require attention. (Much of this is loose and rattles and should be tightened in any event.)

(v) Provide diffusion on the rear wall of the balcony to stop echoes.

(vi) Provide more ornamentation on the ceiling to increase diffusion.

(vii) Increase diffusion by treatment of the side walls to 'break up' the smooth surfaces.

The first recommendation has not been carried out because it would be a very expensive operation. However, Southampton City Architect decided that it would be possible to carry out recommendations (ii), (iii) and (iv), postponing consideration of (v), (vi) and (vii) until later.

When the details were considered it was decided that diffusion should be put only on the rear wall and on the ceiling of the stage area as this would save expense and it was thought that a certain amount of interplay between the two side walls would help the performers to hear each other. After some discussion a system of diffusers which would be satisfactory acoustically as well as fulfilling the aesthetic requirements was eventually agreed upon and the work was carried out in the summer of 1963. Fig. 1 shows the arrangement adopted.

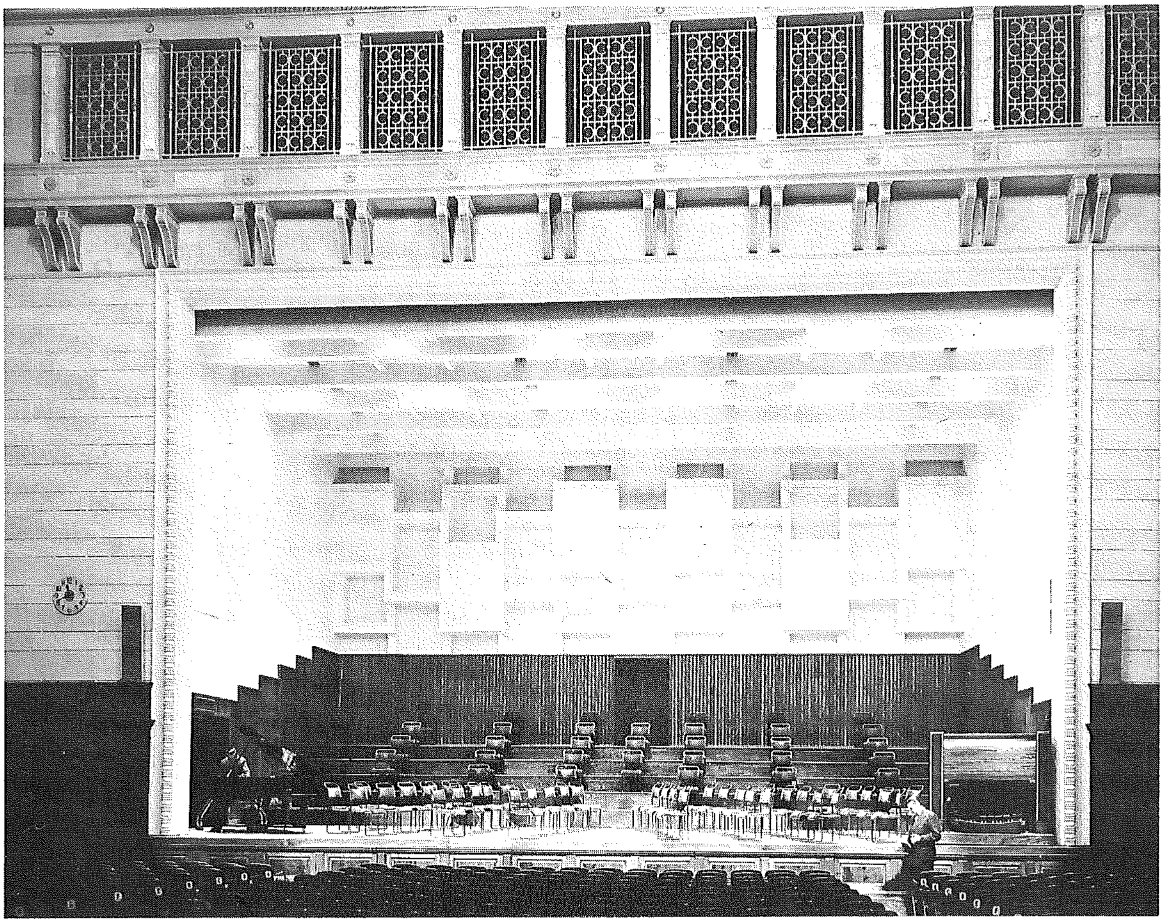

Fig. 1 - Photograph of stage showing diffusing surfaces added to back wall and ceiling

To control the powerful brass and percussion instruments a six-foot high dado consisting of 'knucklebone' slot construction in front of two inches of rockwool covering a seven-inch (18 cm) cavity was provided on the rear wall; there is no absorbing material behind the knucklebone panelling on the side walls. The orchestral rostrum was made permanent and firmly fixed since vibration in the old rostrum was one of the causes of colourations at low frequencies. The other cause of colourations was the side panelling, which was replaced in the reconstruction by knucklebone panelling.

2. ACOUSTIC MEASUREMENTS

2.1. Reverberation Time

The measured reverberation times are shown in Fig. 2. There has been a measurable reduction in reverberation since the modifications and in the presence of the audience the reverberation time is now about 2 seconds. At low frequencies, where the wood strip floor and wood panelled dado round the hall are providing considerable absorption, the reverberation time is perhaps a little too short. At high frequencies air attenuation plus audience inevitably control the reverberation time, the surface treatments having relatively little influence.

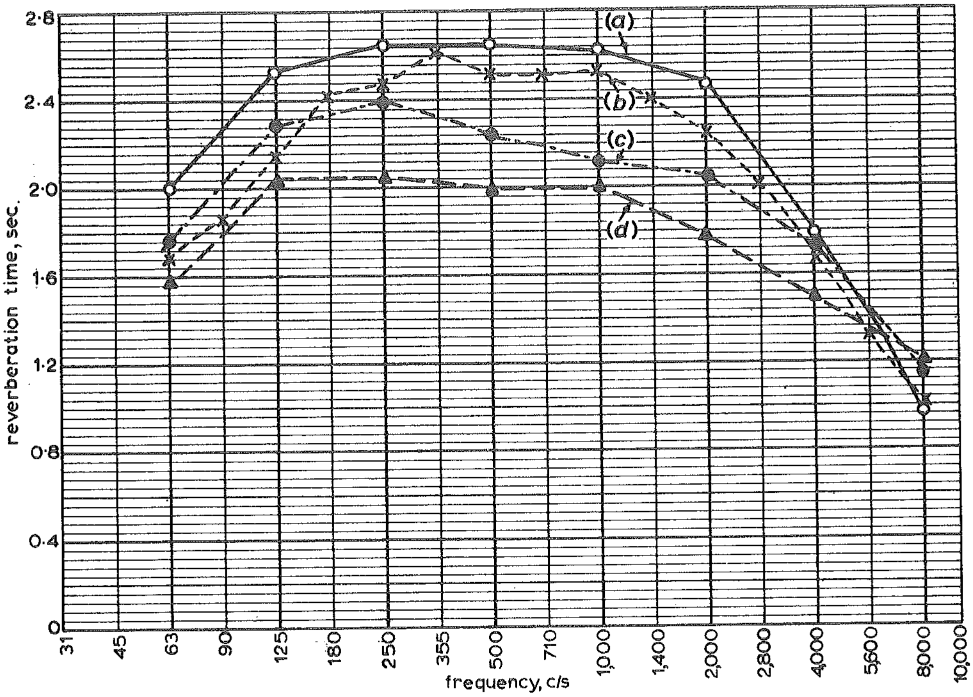

Fig. 2 - Reverberation Time of Guildhall before and after alterations

(a) Before alteration, no audience
(b) After alteration, no audience
(c) Before alteration, ¾ full
(d) After alteration, ¾ full

2.2. Pulse Measurement

The pulse measurements made originally were repeated after the alterations and the results are extremely interesting. Fig. 3 shows a few of the pulse pictures from Research Department Report B-073 and the corresponding pictures after the reconstruction. It will be seen that the diffusers have produced a considerable improvement in the smoothness of the decaying sound with respect to large fluctuations.

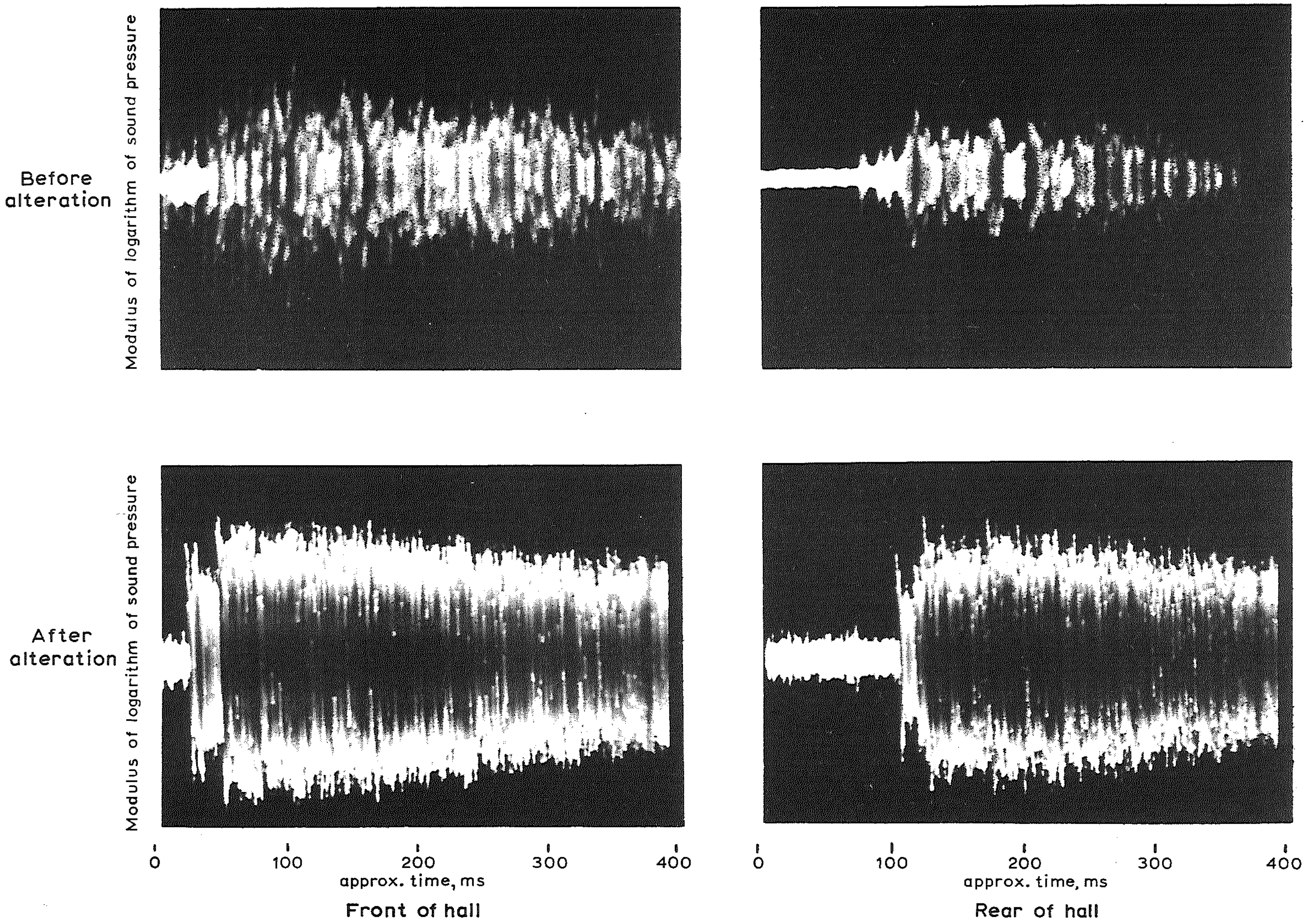

Fig. 3 - Short-pulse reflection displays from two positions in the hall, before and after alterations

3. SUBJECTIVE ASSESSMENT

The first concert in the re-treated Guildhall was a choral and orchestral concert given by the Bournemouth Symphony Orchestra and the Southampton Choral Society. The work was 'Elijah', and was attended by the authors, Dr. Mercer and the City Architect and others. The obvious changes due to the alterations were that the choir and orchestra were much better blended and the balance between them was very good. There was also the impression that the reverberation time was longer than before the modifications although in fact this is not so. The other very surprising result brought about by the diffusion in the stage area is that under the balcony close to the back wall it is quite possible to hear all the intricate detail in the score, although the sound is not so loud as in the open hall. The space under the balcony is 28-feet (8·5 m) from back to front and the height about 10-feet (3 m) so that the good acoustic conditions at the back wall are surprising. The reactions of the choir and orchestra were very favourable. The choir particularly was most enthusiastic because they said that they could hear each other well and were able to pick up their leads much more easily.

The second concert in the hall was given by the London Mozart Players and they were also reported to have been favourably impressed.

The third concert was by the Bournemouth Symphony Orchestra alone which also gave a children's concert in the afternoon at which measurements and recordings were made. With only the orchestra on the stage the impression was of a much better blend and much smoother tone than previously, the strings and woodwind being particularly improved in this respect. Even in complicated passages all the parts came through clearly and the tonal quality was richer. In this concert also the clarity and definition under the balcony were surprising. Previously there were serious bass colourations in this hall. These could no longer be heard so that the double basses and timpani appeared clear and crisp.

A stereophonic recording was made during a children's concert with the same microphone position as was used for the previous recordings.

Although this recording confirms the change in the acoustics of the hall, it had to be done rather hurriedly and does not give a realistic representation. The microphone position was decided by calculation and measurement as there was no time for experimental adjustment and the monitoring conditions were poor. A more representative recording will have to be obtained at a later occasion.

It is not possible immediately a hall goes into use after acoustic modifications, to decide if the results are wholly satisfactory. Some time is required before reliable opinions can be obtained, and it was therefore decided to leave the assessment until the hall had been in use for one complete season, the season running from Autumn 1963 to Spring 1964.

The Manager then asked for comments from the users, and on the whole the general impression of improvement is encouraging. As far as choral performances are concerned the hall gives satisfaction, but Southampton Philharmonic Society is dissatisfied with the tonal control of the organ. This is not surprising in view of the fact that the organ is placed over the stage and the sound comes out above the proscenium. It is therefore difficult for the organist to hear what goes on, but the situation might be improved if recommendation (vi) were implemented and more diffusion added to the ceiling.

Southampton Choral Union also found the improvement worthwhile.

The comments from the Bournemouth Symphony Orchestra were also very interesting. They agree that there has been an improvement, but compared with the other halls they use such as the Winter Gardens, Bournemouth, the Portsmouth Guildhall and Colston Hall, Bristol, they said that they felt 'boxed in'.

It has always been realised that a proscenium has deleterious effects on orchestral music, and it was for this reason that recommendation (i) was made. However, alterations would have been very extensive and extremely costly, and therefore did not appear to be worthwhile. It was, of course, realised from the beginning that it would not be possible to make this hall equivalent in acoustics to some of the old halls such as the pre-war Colston, Free Trade and St. Andrews Halls without extensive modifications.

4. CONCLUSIONS

The re-treatment of the stage area of Southampton Guildhall with diffusing surfaces and absorption close behind the orchestra has confirmed our belief that diffusion is essential to good tonal quality in a concert hall and to enable the performers to be able to hear each other. Good diffusion in the stage area also seems to be very effective throughout the hall, although it might be possible to improve conditions a little more if diffusing surfaces could be added to the ceiling. Even at the most distant parts of the hall the blend and balance of the orchestra is still maintained, although of course the loudness is obviously less towards the rear. Although this hall is much improved it would be worthwhile considering the addition of diffusion to the ceiling, and there are some echoes in the balcony which could be eliminated with advantage.

The users of the hall on the whole seem pleased with the effect of the modifications.

5. ACKNOWLEDGEMENTS

The authors wish to thank Dr. D.M.A. Mercer, Southampton University, and Southampton City Architect, Mr. Leon Berger, for assistance in the experiments.

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Printed by BBC Research Department, Kingswood Warren, Tadworth, Surrey